The maternal behaviour and development of a Little Red Flying-fox *Pteropus scapulatus* in captivity

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ABSTRACT

The Little Red Flying-fox *Pteropus scapulatus* is the most widely distributed flying-fox in Australia yet is the least studied. An injured female was taken in captivity and gave birth to a male. Careful notes were taken of the development of the young and its relationship with the mother as it grew more independent. Similarities were found between the development of *P. scapulatus* and that of the Grey-headed Flying-fox *P. poliocephalus*. Maternal behaviour was similar to that described for *Pteropus* in the wild.

INTRODUCTION

The Little Red Flying-fox *Pteropus scapulatus* is one of four Australian species of fruit bats and is the most widely distributed flying-fox in Australia (Hall 1987). It is also the smallest (Ratcliffe 1932) weighing between 200 and 600 grams. The other species are the Black Flying-fox *P. alecto,* the Spectacled Flying-fox *P. conspicillatus,* and the Grey-headed Flying-fox *P. poliocephalus* (Hall 1987). Little information is available on behaviour of *P. scapulatus* except for its seasonal movements and distribution (Ratcliffe 1931), feeding habits (Law and Lean 1992) and forearm growth (Nelson 1965a). *P. scapulatus* is an important pollinator of *Eucalyptus* (Myrtaceae) (McCoy 1990) and migrates with the blossoming of hardwood trees (Ratcliffe 1931).

Little published information is available on the maternal behaviour or development of *P. scapulatus,* or of the other *Pteropus* species. The most widely studied is *P. poliocephalus.* Until now, behaviour of mother and young *P. scapulatus* has not been recorded.

In the wild, *P. scapulatus* gives birth to only one young per year, between May and April whereas in other species like *P. poliocephalus,* births occur in September-October (Ratcliffe 1931). Nelson (1965b) described the birth of *P. poliocephalus* and the mother-young relationship and noted that the behaviour showed similarities to that of other *Pteropus* species. Ratcliffe (1931) described the seasonal behaviour of the *P. scapulatus,* when large groups form in March to August. Numbers greater than 100 000 have been sighted at one camp (Nelson 1965a).

Studies of individual maternal behaviour and growth of young *P. scapulatus* are difficult because of the problems in identifying individuals in the camps and of handling the young. In February 1996, however, a female *P. scapulatus* was discovered caught in barbed wire at St Andrews, in Sydney's south-west, and was cared for by an experienced animal carer. A male was born 80 days later. The carer took careful notes of the relationship between mother and young and the development of the young during the next eight months.

These observations have provided a remarkable insight into the interactions between mother and young, the growth and development of the young and also how the young achieves independence. This paper records and discusses those observations.

METHODS

The female *P. scapulatus* was discovered with a 12 cm rip in the membrane between her second and third digits in her left wing. The wing could not be repaired as the membrane was too thin. The female seemed otherwise unaffected and was able to climb adequately with both forelimbs.

Mother and young were maintained in a bedroom (Fig. 1) in an open cage. At 0700 and 0900 hours they were given some milk and fruit. At noon mother and young were transported outside in a cage, where they stayed in the shade until 1730 hours. At 1900 hours and later during the evening they were given more milk and fruit. The food provided was based on the carer's experience with flying-foxes.

All the furniture was covered with sheets or blankets to allow them to climb. In winter a lamp (25 watt globe painted red) was provided and five feeding stations were set up (Fig. 1).

Measurements were taken of the forearm (maximum distance from wrist to the elbow,

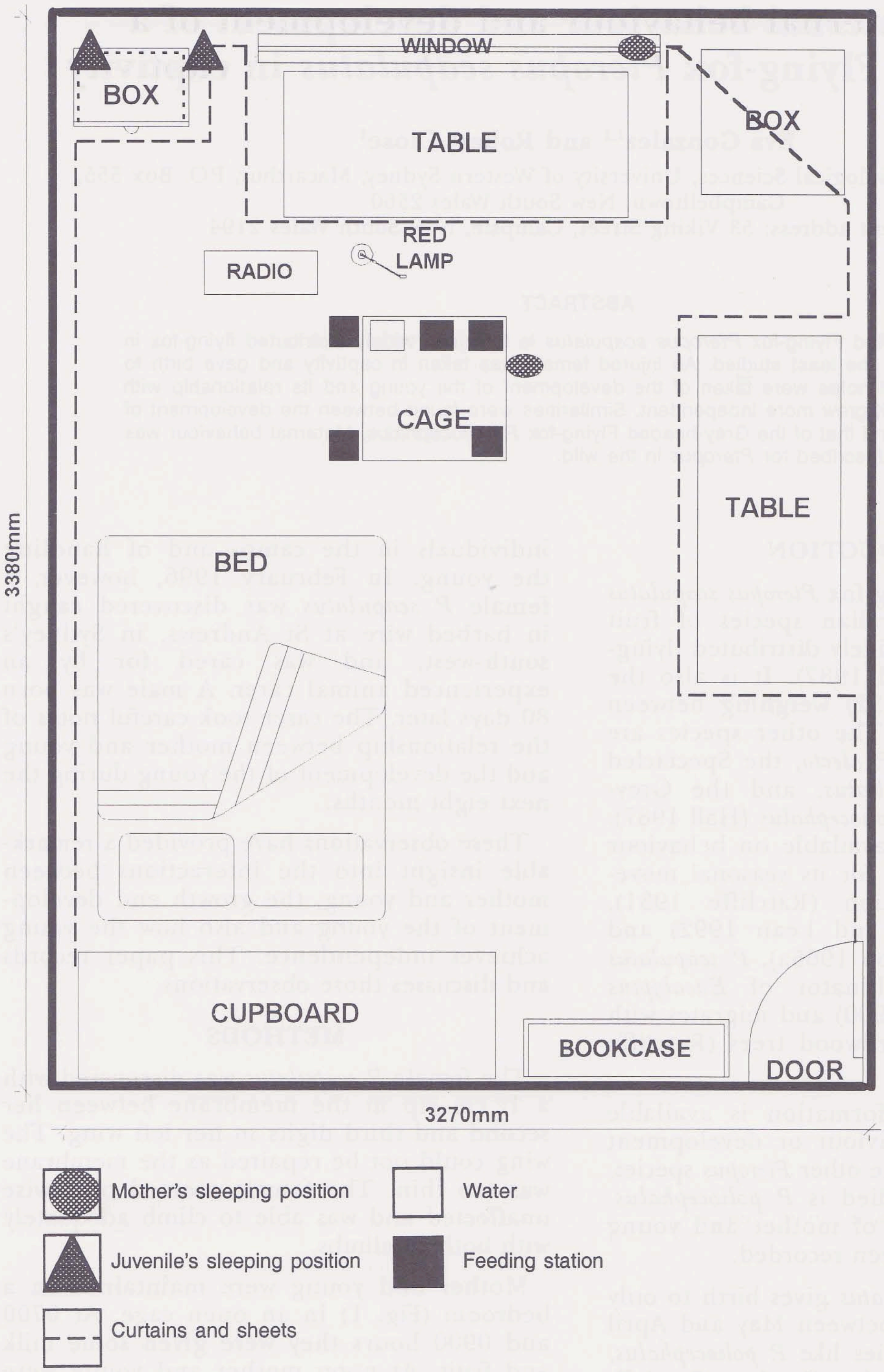
BOX
WINDOW
TABLE
BOX
RED LAMP
RADIO
CAGE
TABLE
BED
3380mm
CUPBOARD
BOOKCASE
DOOR
3270mm
Mother's sleeping position
Water
Juvenile's sleeping position
Feeding station
Curtains and sheets

Figure 1. Room Layout.

with the wing folded) of the young from week 10, using a ruler (Caliper Bergeon 6621[0.1–150 mm]). Earlier measurements were not taken for fear of injuring the mother; the young grips the mother's nipple firmly, and forceful separation of the mother and young can rip the nipple. Weights were taken using a balance (Super Samson/ Salter[1 kg]), after placing the animals in a bag.

Food provided was wattle flowers, grevillea flowers, pears, grapes, kiwi fruit, softened granny smith apple, peach, soaked sultanas, cooked sweetened carrot, puree apple or peach or custard plus peach juice, little lorikeet mix, pollen. The composition of the milk mixture was: six drops of calcium sandox syrup, glucodin, a few drops of cream and 9.5 g of milk powder in 50 ml of water.

The carer kept her contact with the young to a minimum, except where the young initiated interactions. Detailed notes were taken at any time of the day or when a new behaviour/development was observed. As the

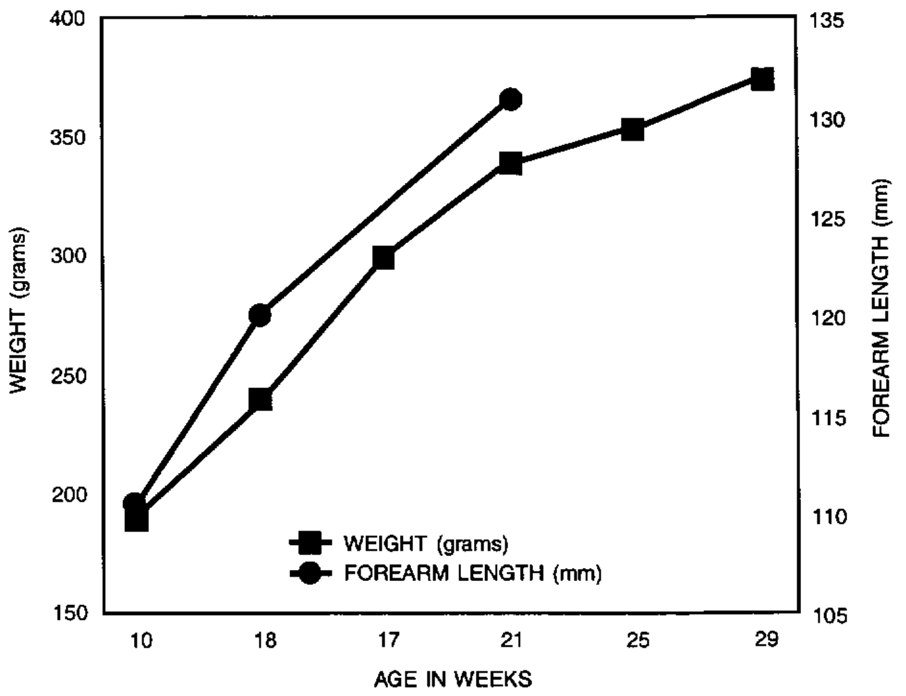

Figure 2. The increase in weight and forearm growth of the young Little Red Flying-fox over weeks 10–29. The final forearm measurement was taken in week 25, when it proved too difficult to measure the young's forearm length.

Table 1. Chronological list of observations of the *P. scapulatus* development from weeks 1–25. Thermoregulation, vocalization and teeth development are treated separately from the rest of the results, to simplify the table.

Week/Date	Observation
10–2–96	Mother discovered. Distinct smell of mother was noted.
30–4–96	Young was born, head first, furred all over except for stomach. Mother lost her distinct smell.
Day 2	At 7 a.m., after eating, mother groomed and cleaned the young's fur and membranes by licking and wrapped him in her wings. Young sometimes looked out from within the wings. Droppings dark and soft. At 7 p.m., after feeding, mother again groomed and wrapped the young.
Day 3	Mother groomed young's face vigorously for one minute. Young licked juice from mother's face, showed interest in container of milk. Suckled for half hour sessions, in short bouts. Mother cleaned young's genital area after he defaecated until day five, he started cleaning himself.
Week 1	Young hung by one leg on rail still wrapped by mother, with other foot hooked into mother's fur.
Week 2	Young almost fully furred. Young would still hold on to the teat and had claws in mother's fur. Mother continuously carried the young.
Week 3	Mother cleaned young's wings for five minutes, after its feed. Young's claws growing, tiny needle-like tips. Hanging by one leg, 3 cm from mother, he would move towards her, but she would step aside making him use his other leg. He put his face into the food container.
Week 4 31–5–96	Young was 15 cm away from mother. Mother still washed young.
Week 5	Young ate four pieces of fruit from container. Young hung in front of mother, flapping his wings vigorously. He climbed independently of mother inside and outside of cage, but called for her (see below).
Week 6 13–6–96	Young flapped regularly.
Week 8 28–6–96	Young hung 15 cm from mother; mother still wrapped him on return.

Table 1 — *continued*

Week/Date	Observation
Week 9 4–7–96	Young managed to get on to a table from cage, 1 m distance from mother. Young lapped milk from mother's container, droppings yellow. Young was found near cupboard, 4 m from mother.
Week 10 10–7–96 11–7–96	Young used claws to draw the milk container closer to him. Took 5 ml of milk per feed, 20 ml per day. Young first flew, 4 m, from cupboard to carer's shoulder. Young preceded flight with flapping of wings for several minutes.
Week 11 7–7–96	Young was teething, teeth pierced a pear with skin.
Week 12 24–7–96 28–7–96	First flew around the room. Young held fruit to chest to eat, chewed one whole pear piece.
Week 13	Young licked flowers of species new to him. Both ate 350 g of fruit per day. Young became trapped behind furniture; when retrieved he hung beside his mother and burrowed into her wing. Both still sleeping wrapped around each other. When alarmed he would half-spread his wings. While mother was being weighed, young appeared concerned and called out to his mother; on its release he immediately hung next to her. Mother was retrieved from behind the blind; the carer interpreted the young's behaviour as appearing concerned. The young flew to mother once retrieved, groomed her broken wing twice, holding it with a claw and he made a crying bird-like noise and covered her with his wing.
Week 14	At night when food dishes are empty, young reached under quilt and gently clawed carer's forehead, apparently to fill up containers with food.
Week 16	Young few to window in early morning. Both mutually groomed, in sunshine in cage and wrapped each other. Young ate 12 pieces of fruit, drank milk from container, no longer suckles from mother.
Week 17	Young groomed mother's face in afternoon. Young's face and front of head becoming grey.
Week 19	Young took 15 ml of milk per day. At 7 a.m. both mother and young groomed one another. Young was scratching own face and stomach while hanging. Placed into the aviary during the day. Mutual and self-grooming. They groomed using all claws at once except near eyes, where they used one.
Week 20	Young's face and forehead now silvery grey with charcoal grey circles around the eyes. Mother always had her milk, young not always. They slept all morning and outside in cage (at noon) they flapped wings and climbed. If it was too hot they moved to back of cage to the shade. At night the young would try to take mother's sleeping spot. Young still hung wrapped by one wing of mother.
Week 25	Young can hover before landing; has done so for a little while (exact date not known).

young became older, no new observations were noted (e.g., week 18, 20–24), therefore no notes were taken. In August 1996, we met the carer and prepared a series of questions to extract additional details. A chronological list of observations was then constructed.

RESULTS

Thermoregulation: In winter, the mother stayed next to a lamp and apparently regulated her temperature by moving towards or away from the light. When the young was born she kept him wrapped in her wings until three weeks of age.

Vocalization: The young squeaked sporadically (sharp, light, short chirps) at birth, and continued for about a fortnight. When playing with the mother he would make a chattering noise and when handled he made a puffing noise, but did not vocalize while flying. He called to his mother when she became trapped behind furniture (Table 1).

Teeth development: Week 19 (22–9–96) was the first time that the carer was able to check teeth development. The incisors were very small and molars were erupting. By week 23, both the lower and upper molars were fully erupted and upper incisors and canines were well developed. One upper incisor i_4, however, was growing at an angle.

Growth and development: The increase in weight and forearm length are shown in Figure 2.

DISCUSSION

The conditions in which behaviour and development of *P. scapulatus* are described in this paper are far removed from natural conditions. In the wild, *P. scapulatus* gather in large, social camps (Ratcliffe 1931; Nelson 1965b). Wilson (1988) noted that injured, pregnant *P. scapulatus* abort their pregnancies. Furthermore, during most of the period described here, *P. scapulatus* would have moved north to warmer areas (Hall 1987). So a suburban bedroom equipped with a red-lamp, used for warmth, was probably a poor substitute. Nevertheless, the insight gained into the interactions of the mother and young and the young's moves to independence are important especially given the lack of published data for the species.

The mother regulated the body temperature of the young, by keeping him wrapped near the lamp in winter, and moving away when warm. As young *Pteropus* are not able to thermoregulate, the mothers thermoregulate them until they grow all their fur, usually after three or four weeks (Nelson 1965b). The mothers are able to pass heat to the young via the naked stomachs of the young.

When the young *P. scapulatus* was born head first, as are all *Pteropus* (Nelson 1965b), the mother immediately licked and appeared to guide the young as he climbed to her nipple. This behaviour was also observed by Nelson (1965b) for other species of *Pteropus* in the wild. At birth the young appeared to have a little fur all over the body, except his stomach area. However, Nelson (1965b) reported that other *Pteropus* are born with naked chests and stomachs. By the second week the young was fully furred.

Martin (1998) suggests that flying-fox carers should not tightly wrap the hind-limbs (in an abnormal position) of infant flying-foxes, but should instead allow them to extend their hind-limbs, as they do in the wild. In this study, when the young was one week old, he hung with one leg attached to the rail and the other to mother. This behaviour supports Martin's concern about the posture of infant flying-foxes. Nelson (1965b) also observed *Pteropus* in the wild, young with one leg attached to a branch and the other to their mother. When the young in the wild are more co-ordinated (three weeks old) they are left in the camps forming clusters to keep warm (Nelson 1965b).

By week three, the mother would encourage the young to hang by himself by moving away from him when he hung with one leg on the rail and the other on her. This forced him to release her and hang by himself. This interaction has not been reported before for *P. scapulatus*. By week four the young was hanging independently, as do *P. poliocephalus* in captivity (George 1990) and in the wild (Nelson 1965b). The young at week five was flapping his wings vigorously, and was also climbing independently of the mother around the inside and outside of the cage, as do British *Nyctalus noctula* (Kleiman 1969).

The mother always cleaned the young's genital area after he excreted until he was six days old, and occasionally thereafter. She continued to groom him after her meals, as do other *Pteropus* species on return from feeding (Nelson 1965b). The mother also carried the young continuously until week three. In the wild the young are carried during flights to feeding grounds (Ratcliffe 1931) until they are three weeks old (Nelson 1965b).

When the young was three days old, he started to lick juice from his mother's face, thereby probably learning what foods were acceptable to eat. George (1990) noted similar behaviour for captive *P. poliocephalus*. George (1990) also noted that captive *P. poliocephalus*, at eight weeks, eat food pre-chewed by their mothers and also from a container. The young *P. scapulatus* at week three was showing an interest in the food container and by week five was eating small pieces of fruit from the container. *P. scapulatus* teeth development, therefore, may be more advanced than that of *P. poliocephalus*. Unfortunately no records of early teeth development were available, because of the difficulty of separating the young from the mother. At week 11, however, the young could pierce pear skin and by week nine was drinking milk from the container, and by week 10, could use his claws to draw the container of milk towards himself. The young also started to hold the fruit to his chest while eating and hanging, at week 12, as the mother did. By week 16, the young was no longer suckling. In other species, the time of cessation of suckling appears to vary from four months to six months (Nelson 1965b). By week 23 the lower molars and upper molars were evenly erupted and the canines and upper incisors were developed. However, one upper incisor was slanted inwards.

The mother continued to wrap the young with her wing, while he hung beside her, till week eight and occasionally at later dates. In the wild there is great variation in the degree of maternal contact, sometimes wrapping or genital cleaning continues beyond four months (Nelson 1965b). The continuation of the interaction with the mother/young could be due to natural variation in mother-infant bonds.

By week nine the young was exploring the room and moved up to 1 m from the mother.

He then progressively moved further from the mother, and by the end of week nine had moved 4 m. By week 10, the young started to make short, straight flights and by week 12 could fly, circling the bedroom. In the wild, *Pteropus* start to fly by week 12 (Nelson 1965b), as do captive *P. poliocephalus* (George 1990). It appears that flight development is the same for all *Pteropus*. By week 25 the young could hover before landing; this has not been reported before for *P. scapulatus*.

Mutual grooming is still common as the young grow older (Nelson 1965b) and in our study was observed in week 13 when the young groomed the mother's torn wing. The young appeared agitated whenever the mother was taken for weighing or became caught in furniture (week 13). On the mother's return the young would move beside her or groom her. Nelson (1965b), observed that *Pteropus* scratch themselves; this was recorded for the captive *P. scapulatus* in week 19. The young *P. scapulatus* would use one claw to scratch around the eyes.

The growth development of the young *P. scapulatus* falls within the average for the species. However, it appears that he reached adult size at an early age; Nelson (1965a) stated that the maximum forearm measurement for *P. scapulatus* is 141 mm and body weight of 604 g for an adult male over 18 months, whereas forearm length of our young at 21 weeks was 131 mm and he weighed 340 g. This compares with the averages stated by Nelson (1965a); adults with 131 mm forearm length, have an average weight of 360 g.

Several calls were recorded. It is difficult to interpret and classify the different calls made. Some calls in the wild are only used in particular situations, such as after a disturbance in the camp, when the animals give an alarm cry. They also make territory warning and sexual calls (Nelson 1965b). The carer interpreted the puffing noise as a response to being disturbed and the chattering with "playing activities". Also the young would make sharp calls to the mother when it appeared concerned. No calls were recorded during flight of the young. Nelson (1964) recorded in a one-day-old flying-fox, short irregular burst of harsh "chirps". The carer also noted sharp, short squeaks sporadically at birth.

Despite the unusual conditions of captivity, this study provides information on the development of the young *P. scapulatus* and maternal interactions which have not been published before, as well as confirming other aspects of behaviour. The *P. scapulatus* maternal behaviour parallels that of other *Pteropus* in the wild and captivity, especially *P. poliocephalus*. Both the wild *Pteropus* and the captive *P. scapulatus* fly at three months, and the process of the young *P. scapulatus* becoming independent follows a similar pattern as for the Australian species of wild *Pteropus*. The feeding behaviour and teeth development of captured *P. scapulatus* may be more advanced than for captive *P. poliocephalus*. This report indicates the contribution that wildlife carers can make to the development of knowledge of our native fauna. Accurate note-taking and collaboration with researchers can supply information that would otherwise prove difficult and costly to obtain.

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